

PLACEMENT OF *HELOPICUS RICKERI* STARK IN *HYDROPERLA* FRISON
(PLECOPTERA: PERLODIDAE) WITH THE DESCRIPTION OF THE
ADULT FEMALE, NYMPH, AND EGG AND A
CLADISTIC ANALYSIS OF *HYDROPERLA*

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Abstract.—*Helopicus rickeri* Stark is transferred to *Hydroperla*, **new combination**. The adult female, nymph, and egg of this species is described and illustrated for the first time. Cladistic analysis of the species in *Hydroperla* indicates that *H. rickeri* and *H. crosbyi* (Needham and Claassen) form a monophyletic group within the genus.

Key Words: Plecoptera, stoneflies, Perlodidae, *Hydroperla rickeri*, *Helopicus*, Nearctic

Stark (1984) described *Helopicus rickeri* from a single male specimen. The generic placement, however, of this distinctive species was speculative. Although he noted that *H. rickeri* differed from other species in *Helopicus* in having two posteroventral spines on the epiproct, Stark tentatively assigned it to this genus because the male lacked lateral stylets, exhibited a similar meso- and metasterna pigment pattern, and displayed structural correspondence with respect to the mesosternal Y-ridge. He concluded that the resolution of the generic placement of *H. rickeri* would have to await the finding of the female and nymph. The recent collecting of these life history stages as well as that of the egg has given me the opportunity to review the generic assignment of *H. rickeri*. In this paper I transfer *H. rickeri* to *Hydroperla* Frison, describe the female, nymph, and egg, and assess, using parsimony analysis, its cladistic relationship with other species in this genus and to that of *Helopicus* Ricker. To facilitate identification of species within *Hydroperla*, I also furnish figures of the females of *H. phormida*, *H. fugitans*, and *H. crosbyi*, as

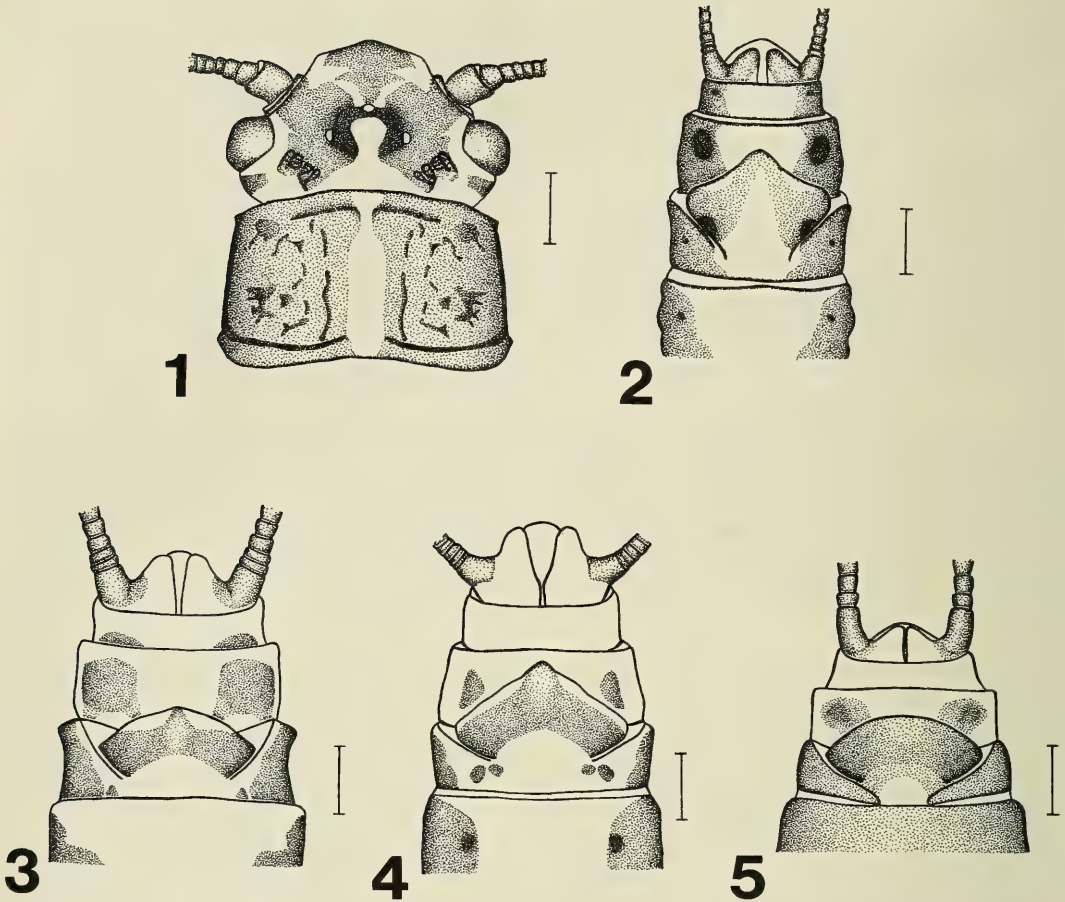
they were not provided in Ray and Stark's (1981) review of this genus.

***Hydroperla rickeri* (Stark),
NEW COMBINATION
(Figs. 1, 2, 6–13)**

Description.—*Male:* As described by Stark (1984). Distinctive epiproct excavated and hood-like apically; tip, in profile, forming a strongly backward directed hook; two elongate spines project from the posteroventral surface (Fig. 7). Lateral stylets absent.

Female: Macropterous. Length of body 17–23 mm; length of forewings 19–23 mm. General body color dark brown to black, patterned with yellow. Dorsal color pattern of head and pronotum as in Fig. 1. Subgenital plate triangular, approximately half as long as rest of sternite (Fig. 2). Sides of S9 and S10 dark, mesal areas yellow (Fig. 2).

Nymph: Length of body mature male 15.5–17 mm; length of body mature female 19–21 mm. General color dull olive green (yellowish brown in alcohol) with dark brown markings (Fig. 6). Fronto-clypeal region, anterior to posterior, bearing four



Figs. 1–5. 1, *Hydroperla rickeri*, adult head and pronotum. 2–5, *Hydroperla*, female terminalia, ventral view. 2, *H. rickeri*. 3, *H. crosbyi*. 4, *H. fugitans*. 5, *H. phormida*. Scale lines = 1 mm.

transverse bands: a narrow light band followed by a broad dark band, then, just anterior to the median ocellus, a broad light band, and, between the antennal bases, a wide M shaped band enclosing three light circular spots. Occiput, between the compound eyes, bearing two incompletely enclosed light oval spots patterned with darker lines. Pronotal margins dark; disc with contrasting light and dark areas. Meso- and metathoracic nota also with a contrasting light and dark pattern (see Fig. 6). Legs, antennae, cerci, and abdominal terga 1–9 all of uniformly light pigmentation. Mouthparts similar to those described and figured for *Hydroperla crosbyi* (Needham and Claassen) by Stewart and Stark (1988), ex-

cept that the mandibular teeth are bluntly, rather than sharply, pointed (Figs. 8–10).

Egg: Length 0.73 mm; width 0.49 mm. General shape oval; in cross-section triangular (Figs. 11, 12). Collar stalked and bearing longitudinal ridges (Fig. 13). Anchor mushroom-shaped (Figs. 11, 13). Chorionic surface partitioned by elevated ridges that form irregularly shaped hexagonal cells, each enclosing numerous punctations.

Specimens examined.—TENNESSEE: Trousdale Co., Rocky Creek, Rt. 25, 22 March 1990, C. H. and C. P. Nelson, 1 male; 24 March 1991, C. H., C. P. and E. S. Nelson, 1 male, 2 exuviae; 28 March 1991, C. H. and C. P. Nelson, 5 males, 1 female, 1 nymph, 6 exuviae; 2 April 1991,

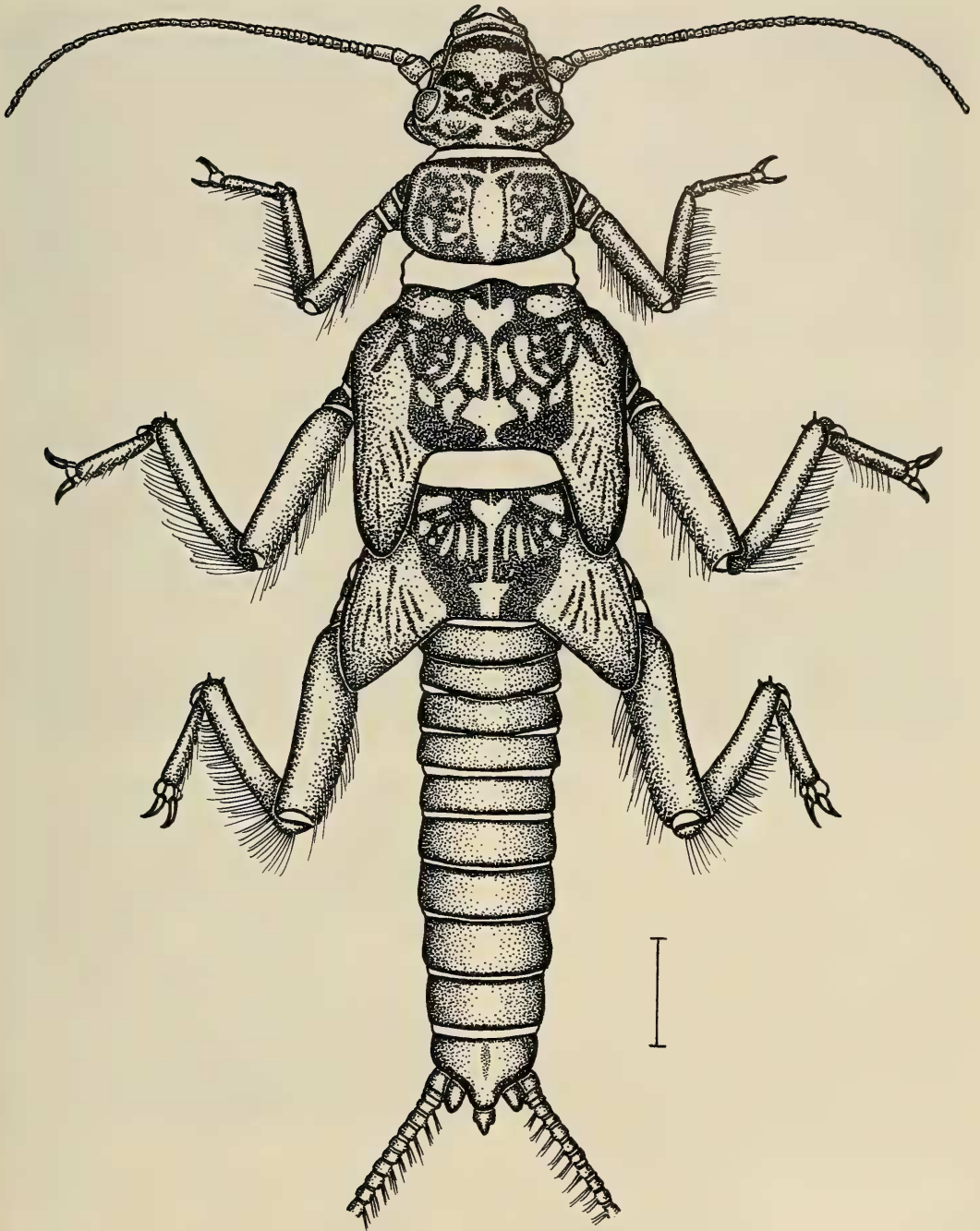


Fig. 6. *Hydroperla rickeri*, mature nymph habitus. Scale line = 2 mm.

C. H. and E. S. Nelson, 9 males, 4 females, 1 nymph, 3 exuviae; 7 April 1991, C. H. and E. S. Nelson, 7 males, 7 females, 1 nymph, 12 exuviae; 5 April 1992, C. H. and

E. S. Nelson, 18 males, 4 females, 9 nymphs, 22 exuviae; 8 April 1993, C. H. Nelson, 1 male; 13 April 1994, 1 male, 1 female; tributary of Rocky Creek, Rt. 25,



Figs. 7–10. *Hydroperla rickeri*. 7, Male epiproct (150×). 8, Nymphal mandible (150×). 9, Nymphal lacinia (150×). 10, Nymphal labrum (150×).

28 March 1991, C. H. and C. P. Nelson, 2 exuviae; 8 April 1993, C. H. Nelson, 7 exuviae; 1 April 1994, C. H. Nelson, 1 male; 13 April 1994, C. H. Nelson, 2 females (reared), 2 exuviae; Little Goose Creek, Rt. 25, 22 March 1990, C. H. and C. P. Nelson, 1 male; 28 March 1991, C. H. and C. P. Nelson, 2 exuviae; Second Creek, Sulphur College Road, 24 March 1991, C. H., C. P. and E. S. Nelson, 2 exuviae; 28 March 1991, 5 exuviae; 8 April 1993, C. H. Nelson, 2 exuviae.

Remarks.—*Hydroperla rickeri* and all others in this genus can be distinguished from species in *Helopicus* and other *Perlodini* genera by the following combination of features: (1) anterodorsal surface of the apex of the male epiproct appearing excavated, (2) posteroventral surface of the apex of the male epiproct with two downward

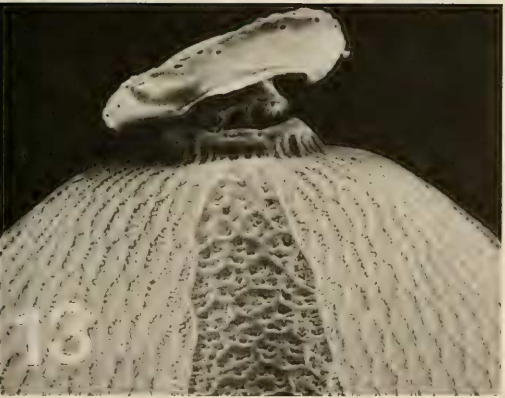
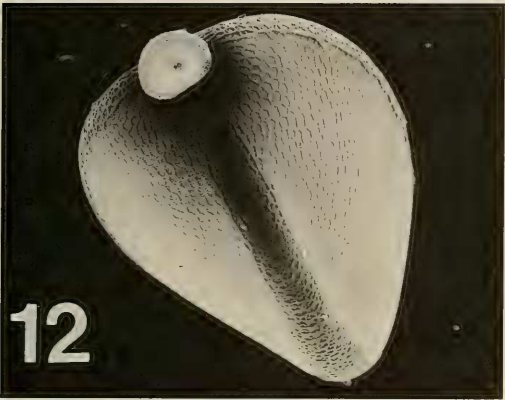
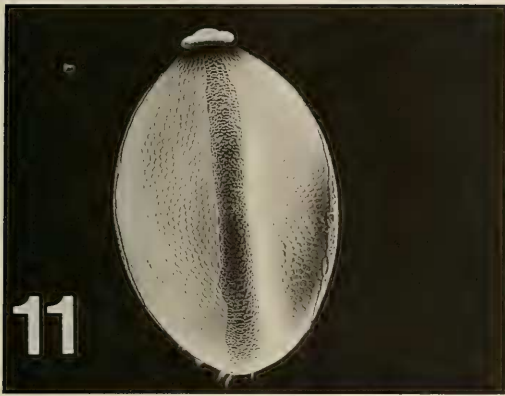
directed spines, (3) transverse dark M band of nymphal fronto-clypeal region with 3 light spots, (4) nymphal mandible with 4 teeth, (5) teeth of nymphal mandible without serrations, (6) nymphal lacinia with outer patch of setae, (7) egg collar without 3 short spike-like processes.

This species is only known from small to mid-sized streams of the Cumberland Plateau of Tennessee. Other stonefly species collected with *H. rickeri* include *Clioperla clio* (Newman) and *Amphinemura nigrutta* (Provancher).

KEY TO THE SPECIES IN *HYDROPERLA* MALES

(Males of *H. crosbyi*, *H. fugitans*, and *H. phormida* are illustrated by Ray and Stark, 1981)

1. Epiproct tip, in profile, forming a strongly backward directed hook (Fig. 7) 2



Figs. 11–13. *Hydroperla rickeri* egg. 11, Whole egg, lateral (150×). 12, Whole egg, oblique dorsal (150×). 13, Detail of anchor and collar (500×).

- Epiproct tip, in profile, somewhat erect 3
- 2. Lateral stylets present; spines projecting from posteroventral surface of epiproct small, less than 1/2 as long as apical hook
 *H. crosbyi* (Needham and Claassen)
- Lateral stylets absent; spines projecting from posteroventral surface of epiproct elongate,

- about as long as the apical hook (Fig. 7) . . .
 *H. rickeri* (Stark)
- 3. Epiproct anterodorsal surface with a small forward directed barb projecting from the margin of each side
 *H. fugitans* (Needham and Claassen)
- Epiproct anterodorsal surface lacking any forward directed barbs, margin of each side smoothly contoured *H. phormida* Ray and Stark

FEMALES

1. Head with light pigment bordering all or nearly all of dorsal margin of eye (Fig. 1); abdominal sternum 10 with a dark pigment spot or area on each side (Figs. 2, 3) 2
- Head with dark pigment bordering all or nearly all of the dorsal margin of eye; abdominal sternum 10 without dark pigment spots or areas (Figs. 4, 5) 3
2. Postocular areas of occiput with a dark pigment spot (Fig. 1); subgenital plate triangular and about one half as long as rest of sternite (Fig. 2) *H. rickeri* (Stark)
- Postocular areas of occiput lacking a dark pigment spot; subgenital plate rounded and about one third as long as rest of sternum (Fig. 3) *H. crosbyi* (Needham and Claassen)
3. Abdominal sterna 2–7 with a broad mesal light pigmented band; subgenital plate triangular (Fig. 4) . . . *H. fugitans* (Needham and Claassen)
- Abdominal sterna 2–7 uniformly darkly pigmented; subgenital plate rounded (Fig. 5) *H. phormida* Ray and Stark

NYPHS

1. Dark pigment band of anterior fronto-clypeal region transverse and broad (Fig. 6); abdominal terga 1–9 each with uniform light pigmentation or with a transverse dark pigment band on the anterior half 2
- Dark pigment band of anterior fronto-clypeal region consisting of two dark pigment spots or four dark pigment patches, two mesal and two lateral, connected by a narrow band; abdominal terga 1–9 each with a row of small dark pigment spots 3
2. Abdominal terga 1–9 each with a transverse dark pigment band on anterior half
 *H. crosbyi* (Needham and Claassen)
- Abdominal terga 1–9 each uniformly lightly pigmented (Fig. 6) *H. rickeri* (Stark)
3. Dark pigment band of anterior fronto-clypeal region consisting of two dark pigment spots; anterior margin of labrum not expanded mesal-

Table 1. Character data matrix for *Hydroperla* species.

Taxa	Characters																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
<i>Hydroperla crosbyi</i>	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	0	1	1
<i>Hydroperla fugitans</i>	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	1	0	1
<i>Hydroperla phormida</i>	0	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0
<i>Hydroperla rickeri</i>	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	0
<i>Helopicus</i>	1	1	(01)	1	1	1	0	1	(01)	0	(01)	0	0	0	0	0	0	0	0	(01)	0	0

- ly into a central lobe
- *H. fugitans* (Needham and Claassen)
- Dark pigment band of anterior fronto-clypeal region consisting of four dark pigment patches, two mesal and two lateral, connected by a narrow band; anterior margin of labrum expanded mesally into a central lobe
- *H. phormida* Ray and Stark

CLADISTIC ANALYSIS

For this analysis, I selected *Helopicus* as the outgroup to assess cladistic relationships of *H. rickeri* and its congeners. *Helopicus*, widely distributed in eastern North America, includes three species and is regarded by Stark and Ray (1983) as being most closely related to *Hydroperla*. Twenty two two-state characters listed below and in Table 1 were analyzed using PAUP 3.1.1 (Swofford 1993) and MacClade 3.0 (Madison and Maddison 1992):

1. Three short spike-like processes of egg collar present (0), or absent (1).
2. Transverse dark pigment band of nymphal anterior fronto-clypeal region uniformly broad (0), or broken up, consisting of spots or patches, or is absent (1).
3. Transverse M band of nymphal fronto-clypeal region with anterior margin M-shaped (0), or straight (1).
4. Transverse M band of nymphal posterior frons interrupted by three light spots (0), or not interrupted (1).
5. Nymphal mandible lacking distinct serrations with teeth (0), or with serrations (1).

6. Right nymphal mandible with 4 teeth (0), or with 5 teeth (1).
7. Teeth of nymphal mandible sharply pointed (0), or bluntly pointed (1).
8. Outer patch of setae on nymphal lacinia present (0), or absent (1).
9. Mesal area of nymphal labium strongly produced (0), or weakly or not produced (1).
10. Dorsal eye margin of adult bordered by dark pigment (0), or light pigment (1) for all or nearly all of its distance.
11. Transverse dark band of adult mesosternum not interrupted (0), or interrupted (1) by an area of light pigment on either side of the midline.
12. Male hemitergal lobes broadly rounded (0), or thumb-like (1).
13. Male lateral stylets absent (0), or present (1).
14. Paired barbs on posteroventral surface of male epiproct absent (0), or present (1).
15. Paired barbs on posteroventral surface of male epiproct much shorter than (0) or about as long as (1) apical hook.
16. Apex of male epiproct excavated and hood-like (0), or cylindrical or flattened (1).
17. Acute or truncate forward directed projections of male epiproct absent (0), or present (1).
18. Forward directed projections of male epiproct little expanded (0), or greatly expanded (1).
19. Backward directed hook at apex of male epiproct absent (0), or present (1).

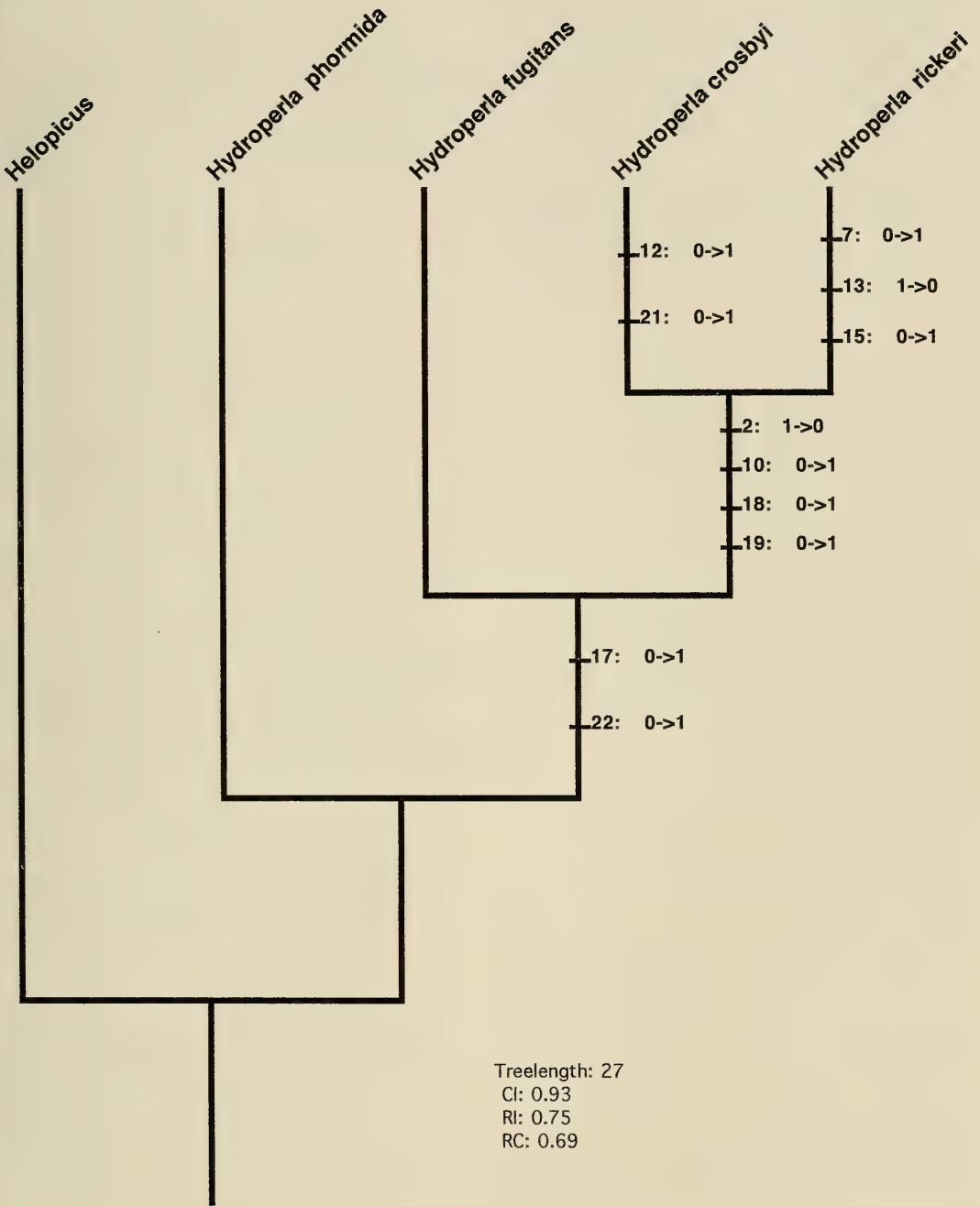


Fig. 14. Cladogram of the species of *Hydroperla* with the outgroup *Helopicus* that results from using the branch and bound option of PAUP to analyze the character matrix in Table 1. Character numbers associated with tick marks indicate unambiguous changes.

20. Female subgenital plate rounded (0), or triangular (1).
21. Female subgenital plate one half as long as rest of sternite (0), or less than one quarter as long as the rest of sternite (1).
22. Posterior margin of female subgenital plate uniformly dark pigmented (0), or interrupted with an area of light pigmentation on either side of the midline (1).

A single most parsimonious tree (Fig. 14) was found using the branch and bound option of PAUP. The tree length was 27, the Consistency Index (CI) was 0.93, the Retention Index (RI) was 0.75, and the Rescaled Consistency Index (RC) was 0.69. *H. rickeri* together with *H. crosbyi* form a monophyletic group within the *Hydroperla* clade. Although Stark (1984) suggested that the similarity of the epiprocts of *H. rickeri* and *H. crosbyi* males was superficial, the tree generated here indicates that this similarity reflects an underlying close phylogenetic relationship.

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